

Lidar Testing

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Coherent lidar testing, performed in FY96 for scientific and/or engineering purposes, included two airborne programs and one ground-based program in which lidar groups from several agencies and companies participated. The cooperative efforts allowed pooling of resources and expertise to accomplish the research objectives, and resulted in cost savings through the use of existing equipment and sharing of data.

The Multi-center Airborne Coherent Atmospheric Wind Sensor (MACAWS) is an airborne, scanning coherent Doppler lidar designed to acquire remote multi-dimensional measurements of winds and absolute aerosol backscatter in the troposphere and lower stratosphere. These measurements enable study of atmospheric dynamic processes and features at scales of motion that may be undersampled by, or beyond the capability of, existing or planned sensors. MACAWS capabilities enable more realistic assessments of concepts in global tropospheric wind measurement with satellite Doppler lidar, as well as a unique capability to validate the NASA Scatterometer. MACAWS consists of a Joule-class carbon dioxide (CO₂) coherent Doppler lidar on a ruggedized optical table, a programmable scanner to direct the lidar beam in the desired direction, and a dedicated inertial measurement unit to account for the variable aircraft attitude and speed. MACAWS was flown for the first time in September 1995, and a second time in June 1996, aboard the NASA Ames Research Center DC-8 aircraft, over the eastern Pacific Ocean and western United States. MACAWS was jointly developed by the lidar atmospheric remote sensing groups of Marshall, the National Oceanic and Atmospheric Administration (NOAA), the Environmental Technology Laboratory and the Jet Propulsion Laboratory (JPL). Existing components were used

where possible to minimize costs. The CO₂ lidar transceiver was provided by NOAA, based on their highly successful WindVan system. MSFC provided an existing scanner and inertial measurement unit, and JPL provided an existing optical table. Some modifications were required to ensure DC-8 compatibility and flight safety.

The MSFC lidar atmospheric remote sensing group cooperated with the Air Force, Wright Laboratory in their Ballistic Winds program. A flashlamp-pumped, chromium, thulium:yttrium aluminum garnet (Cr,Tm:YAG) 100-mJ, 7-Hz lidar transceiver, built for MSFC by Coherent Technologies, Inc. under Small Business Innovative Research (SBIR) and RTOP funding, was used by the Air Force to improve the accuracy of air drops by a factor of 2 to 10 times over conventional methods. Unguided, parachuted cargo and conventional bombs, dropped from aircraft, are affected by the winds between the aircraft and the ground. The cargo release point can be adjusted to compensate for the intervening winds if they are known. Conventional methods of obtaining the winds such as rawinsondes are not always available and an alternate method of using the aircraft true air speed at various altitudes to infer winds is incomplete and compromises aircraft safety. The MSFC lidar transceiver was ruggedized by the U.S. Air Force and installed in a C-141, profiling winds beneath the aircraft in real-time in a series of tests from June 1995 through March 1996.

Because of its potential for efficient, compact, and long-lived operation with diode-pumping, new eye-safe, 2 μ m lidar technology using thulium- and/or holmium-doped solid-state lasers is being considered for satellite-based wind sensing as well as other airborne and ground-based wind sensing applications. The lidars rely on signals backscattered from entrained atmospheric aerosols to make the wind measurement. Knowledge of atmospheric backscatter levels is necessary to specify such lidar parameters as output power and telescope aperture size to ensure that wind

measurements can be made reliably at the locations and to the altitudes required. A backscatter measurement program was conducted in FY96 using an existing Air Force 2 μ m lidar to collect nominally weekly, calibrated backscatter data at various locations in the United States. The data were collected by Coherent Technologies, Inc. under contract to MSFC.

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Biographical Sketch: Steve Johnson is an electrical engineer in the Electro-Optics Branch at MSFC working on space-based, airborne and ground-based coherent lidar systems and components. He received a BSEE from Purdue University in 1977 and an MSEE from the University of Alabama in Huntsville in 1987. 